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ABSTRACT

Two hundred children (100 girls and 100 boys), kindergarten through fourth grade, were tested with the Matching Familiar Figures Test (MFF) and a newer instrument, the Multi-Choice Conceptual Tempo Apparatus (MCCTA). The MCCTA was more reliable and had stronger negative correlations between errors and latency than did the MFF. The MCCTA did not correlate with either School and College Ability Test or the California Achievement Test on verbal, numerical and total scores. MCCTA errors correlated positively with MFF errors. High latency scores on the MCCTA tended to also delay their response on the MFF. The MCCTA appears to be a better instrument for the measurement of Conceptual Tempo than the MFF. (Author)

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MEASURING REFLECTION IMPULSIVITY ACCURATELY

Kagan has isolated a psychological construct, reflection-impulsivity, which attends to the differential decision times in problem solving situations. A child is classified as impulsive if he is above the median on matching errors and below the median on response time for a group of children his own age and grade on the Matching Familiar Figures Test. Conversely, a reflective child is one whose response times are above the median and his error score below the median (Kagan, 1966). The median split method invariably produces a group of children who cannot be classified as clearly reflective or impulsive unless a perfect, negative correlation (-1.00) is reported. That is, as correlations between errors and response times approach -1.00, the ambivalent group becomes smaller. Low negative correlations between latency and errors, then, are not desirable.

The MFF has produced correlations on the variables response time and errors of -.57 for boys and -.51 for girls. The ability of the MFF to elicit moderately high negative correlations has prompted Kagan to conclude that the MFF is "The most sensitive test for this variable (reflection-impulsivity)... (1966, p. 119)". Moderately high correlations generally leave unclassified approximately one third of the subjects. Clearly, a more reliable instrument which would produce correlations between latency and errors greater than those reported above would be highly beneficial to researchers needing to isolate the construct conceptual tempo more accurately. MFF reliabilities have generally been low to moderate (Kagan, 1965; Ayabe, 1968).

Dunn-Rankin (1970, unpublished study) reported using sophisticated testing equipment developed at Bell Laboratory whereby latency and errors were accurately recorded. Raw data from a pilot study was available and the correlation between errors and response times was calculated, $r = -.67$, 8 df, $p < .05$.

It appears that the electronic equipment utilized by Dunn-Rankin produced a high negative correlation between latency and errors because: 1) the instrument allowed many items to be presented in a relatively short time, i.e., 168 items in approximately 25 minutes. In contrast, the MFF has only 12 items but each administration of the test requires about 15 to 25 minutes. 2) the instrument seems to require less of a memory load than the MFF. 3) the instrument lessens the chances of error in gathering latency data. For example, the administration of the MFF requires the use of a stop watch but the exact time when the subject begins and when he reports his answer is not readily discernible to the experimenter. With the Dunn-Rankin apparatus, the subject reports his answer by depressing a switch which automatically stops the digital clock, thus reducing errors in measuring the time the subject takes to respond.

Although it appears that this instrument is superior to the MFF one cannot be certain from the data presented. An r equal to -.67 is impressive but there are several drawbacks. First, the n was only 10. With a small sampling population, the possibility of a spuriously high or low correlation is increased. Secondly, the sample contained a highly heterogeneous group -

ages ranged from 11 to 41. Thirdly, the Dunn-Rankin items were too easy (errors ranged from 4 through 10 out of 168 items) and not designed to elicit reflective behaviors. Thus, the question is raised, would items specifically designed to elicit the R-I behaviors when used with the apparatus produce correlates favorable to the measuring of reflection impulsivity.

METHOD

Materials.

Matching Familiar Figures Test (MFF). The MFF, a twelve item test for reflection-impulsivity as described in the rationale portion, was used.

Multi-Choice Conceptual Tempo Apparatus (MCCTA). The MCCTA with a digital clock and viewer was built. The schematic diagram is attached. The apparatus presented two line drawings simultaneously by means of a shutter and required the subject to make a judgment as to whether the two figures were alike or different. The subject reported his answer by depressing one of two switches, which indicated his choice. The switches were attached to the digital clock which automatically turned the timer off. Items for the MCCTA were constructed using figures similar to those in the MFF.

Subjects.

Two hundred children, 40 children (20 girls, 20 boys) from each grade level -- kindergarten through fourth grade were randomly selected to serve as subjects (Ss). Most studies [Ayabe, H. I. and Gotts, E. E., 1967; Kagan, J., 1965a, 1965b, 1965c, 1966a; Kagan, J., Pearson, L., Welch, L., 1966b; Siegelman, E. Y., 1966; Ward, W. C., 1966, 1968a, 1968b; Yando, R. M., 1966; Kagan, J. and Yando, R. M., 1968] in the area of conceptual tempo were conducted with children of that age group, thus providing comparative data.

Procedure.

Subjects were administered both the MFF and the new instrument with the MCCTA randomly balanced for the order effect; i.e., through random assignment one half of each subgroup was administered the MFF first while the other half was administered the new test first.

Directions for administering the MCCTA are as follows: "Place both hands on buttons; right means alike and left means different." With kindergarten subjects, the tester places the subjects' hands on each button stating directions at the same time. With non-kindergarten subjects, the tester observes whether the directions have been understood. Then say, 'When the window opens, press the right button if the pictures, words or numbers are alike. Press the left button if the pictures, words or numbers are different. Let's try one." The tester then shows practice items and helps the child in determining whether the pictures, words, or numbers are alike and in pressing the correct button. Thirteen practice items are given.

Age, intelligence and/or achievement test score data were extracted from the school files.

RESULTS

Kuder-Richardson (KR 20) and Spearman Brown (S-B) split half reliabilities were computed for both tests, Matching Familiar Figures (MFF) test and the Multi-Choice Conceptual Tempo Apparatus (MCCTA) at all levels separately and all levels together. The MFF KR-20 reliabilities ranged from .216 to .444 by grade levels and total while MCCTA KR-20 reliabilities ranged from .683 to .825. The MFF S-B split half reliabilities ranged from .118 to .509 by grade levels and total while MCCTA S-B split half reliabilities ranged from .815 to .867. Thus, the highest reliabilities reported for the MFF did not exceed the lowest reliability reported for the MCCTA (See Table I).

Insert Table I about here.

Intercorrelations between the variables age, MFF error on first choice, MFF error to criteria, MFF latency, MCCTA error and MCCTA latency for all grades together and kindergarten are shown in Table II, first grade and second grade are shown in Table III, and third and fourth grade are shown in Table IV.

Insert Table II, III and IV about here.

First, second, third and fourth grade children and all grade levels together tended to produce fewer errors when more time was spent on the MFF. However, the relationship between errors and time on the MFF was not significant for kindergarteners. Correlations ranged from -.1076 to -.6579 having an average correlation of -.4936.

At all grade levels separately and all children together, there were reliable negative correlations between errors and latency on the MCCTA, that is, slow responders make fewer errors. Correlation ranged from -.6932 to -.8688 with an average correlation of -.7753.

Intercorrelations between age, MFF errors on first choice, MFF errors to criterion, MFF latency, MCCTA errors, MCCTA latency, School and College Ability Test (SCAT) verbal, SCAT numerical, SCAT total, California Achievement Test (CAT) verbal, CAT numerical and CAT total for grades three and four are given in Table V. Aptitude and achievement scores were not available for grades K through 2. There were no significant correlations between MFF and MCCTA variables with variables of the SCAT or CAT.

The age, MFF error on first choice, MFF error to criterion, MFF latency, MCCTA error and MCCTA latency means for each of the grade levels, kindergarten through fourth grade, are shown in Table VI.

Insert Table V, VI about here.

DISCUSSION

Reliabilities computed by either the Kuder-Richardson (KR 20) or Spearman-Brown (S-B) split half method has shown that the Multi-Choice Conceptual Tempo Apparatus (MCCTA) measures more consistently than the Matching Familiar Figures Test (MFF). Test reliabilities for the MFF ranged from low to moderate (.118 to .509) while reliabilities were consistently high for the MCCTA (.683 to .867) for all grade levles separately and together.

The results also indicate that the MCCTA may be valid for measuring the personality disposition, conceptual tempo: reflection-impulsivity. A reflective child is one who takes longer to respond to questions of high response uncertainty and makes fewer errors than his counterpart, the impulsive. Thus, any instrument which purportedly measures conceptual tempo must elicit a negative correlation between time to respond and amount of errors produced, that is subjects with high latencies should produce few errors and vice versa.

The MCCTA produced high negative correlations between latency and errors with no correlation below -.6932 and an average correlation of -.7753. The MFF did not perform as well. The highest negative correlation elicited by the MFF (-.6579) was not higher than the lowest correlation elicited by the MCCTA. Moreover, a negative correlation, -.1076 for kindergarteners was not reliably different from zero. The MCCTA appears to be more valid than the MFF for measuring conceptual tempo.

Neither the MCCTA nor the MFF variables correlated with School and College Ability Test (SCAT) verbal, numerical or total score or the California Achievement Test (CAT) verbal, numerical and total scores. The MCCTA and the MFF measures a construct other than intelligence or achievement.

Nevertheless, one might ask, do the MCCTA error and latency variables correlate with MFF error and latency variables? The MCCTA error scores correlated positively with both the MFF error on the first choice and MFF error for criterion scores, while the latency scores of the MCCTA correlated with the latency scores of the MFF. These results indicate that both the MCCTA and the MFF are measuring the same construct. It should be noted that MCCTA error is also correlated negatively with the MFF latency. However, latency on the MCCTA did not produce a reliable negative correlate with either the MFF errors on first choice or the MFF error to criterion.

Conceptual tempo, according to Kagan (1965a, 1965b), is age related, i.e., the older the child, the more reflectively he behaves, thus producing longer latencies and fewer errors. The MFF error on first choice, MFF error to criterion, MFF latency and MCCTA error correlates support Kagan's earlier finding. The MCCTA latency scores, however, correlate negatively with age, that is, the older one becomes, the greater is the tendency to hurry.

It appears response time on the MCCTA has a non-monotonic relationship with age. Kindergarteners produce the highest latency scores ($\bar{X}$ = 187.59 seconds) followed by the first graders with a mean equal to 163.35. The lowest scores are the second graders ($\bar{X}$ = 110.78). Third and fourth graders produce longer latencies $\bar{X}$ = 161.83 and $\bar{X}$ = 131.00 respectively (See figure 1). The longer latency of the younger subjects is probably attributed to eye hand coordination, lack of development rather than to conceptual strategy. If conceptual strategy were the cause, that is, longer looks to maximize scanning and analytical time, then one would expect a lowering of the error rate (kindergarten produced the most errors instead). The MCCTA does appear to depend somewhat on eye-hand, left-right, visual-haptic modalities. If this is the case, future studies may incorporate a method for leveling for the skill-effect by perhaps extracting a base rate of button pressing activity.

In sum, the MCCTA is more reliable and perhaps more valid for measuring conceptual tempo than the MFF. Further studies need to be conducted to eliminate the curvilinear effect of latency to age on the MCCTA and to further validate the instrument.

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TABLE I

Kudar-Richardson 21 and Spearman-Brown Split Half Reliabilities for each grade level and all grade levels together.

	MFF		MCCTA	
	Kuder	Spearman	Kuder	Spearman
Kindergarten	0.274	0.132	0.781	0.840
First Grade	0.216	0.118	0.683	0.849
Second Grade	0.256	0.305	0.825	0.833
Third Grade	0.432	0.465	0.819	0.867
Fourth Grade	0.444	0.509	0.812	0.815
All Grades	0.428	0.416	0.798	0.848

TABLE II

INTERCORRELATION OF MFF, MCCTA AND AGE VARIABLES FOR THE TOTAL GROUP AND KINDERGARTEN

Variables	1	2	3	4	5	6
1. Age		-0.4272**	-0.5116**	0.2373**	-0.2556**	-0.1440*
2. MFF error first	-0.0802		0.8120**	-0.5399**	0.3295**	-0.0611
3. MFF error crit	-0.1180	0.6953**		-0.5567**	0.3867**	-0.0832
4. MFF latency	-0.0855	-0.1076	-0.2543		-0.3383**	0.2371**
5. MCCTA error	-0.1598	0.2673	0.4096**	0.2725		-0.6932**
6. MCCTA latency	0.1774	-0.0227	-0.3080	0.1103	-0.7712**	

Note: Total group to the right and above the diagonal. N = 40
Kindergarten to the left and below the diagonal. N = 40

* $p < .05$

** $p < .01$

TABLE III

INTERCORRELATION OF MFF, MCCTA AND AGE VARIABLES
FOR FIRST AND SECOND GRADE

Variables	1	2	3	4	5	6
1. Age		-0.2494	-0.1673	-0.0310	-0.0317	0.0338
2. MFF error first	0.1012		0.7253**	-0.5149**	0.0157	-0.0127
3. MFF error crit	-0.0472	0.7648**		-0.5289**	-0.0621	0.1102
4. MFF latency	-0.1031	-0.6028**	-0.5310**		-0.0411	0.1935
5. MCCTA error	-0.2092	0.1447	0.2130	-0.0655		-0.7916**
6. MCCTA latency	0.1467	-0.1265	-0.1954	0.1390	-0.8688**	

Note: First Grade to the right and above the diagonal. N = 40
Second Grade to the left and below the diagonal. N = 40

* $p < .05$

** $p < .01$

TABLE IV

INTERCORRELATION OF MFF, MCCTA AND AGE VARIABLES
FOR THIRD AND FOURTH GRADE

Variables	1	2	3	4	5	6
1. Age		-0.1853	-0.2141	-0.0073	0.2087	-0.0928
2. MFF error first	0.0501		0.7912**	-0.4504**	0.1479	-0.0433
3. MFF error crit	-0.1010	0.8853**		-0.5597**	0.3148	-0.1423
4. MFF latency	0.2902	-0.6188**	-0.6579**		0.4138**	0.4100**
5. MCCTA error	-0.2237	0.5991**	0.6640**	-0.6731**		0.7249**
6. MCCTA latency	0.1259	-0.6076**	-0.6731**	0.7409**	-0.8021**	

Note: Third Grade to the right and above the diagonal. N = 40
Fourth Grade to the left and below the diagonal. N = 40

* $p < .05$

** $p < .01$

Table V

Intercorrelation Between Age, MFF, MCCTA,
SCAT and CAT Variables for Third and Fourth Graders

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Age		-0.1117	-0.1544	0.1510	0.0936	-0.1449	-0.0989	-0.0549	-0.0861	0.0045	0.0707	0.0402
2. MFF error first	-0.1117		0.8428**	-0.5410**	0.3536**	-0.2768*	-0.0802	-0.0239	-0.0532	-0.1184	-0.0422	-0.0810
3. MFF error crit	-0.1544	0.8428**		-0.6142**	0.4751**	-0.3399**	-0.1191	-0.0882	-0.1108	-0.1991	-0.1346	-0.1704
4. MFF latency	0.1510	-0.5410**	-0.6142**		-0.5262**	0.5307**	-0.0890	-0.0951	-0.0969	0.0012	-0.0814	-0.0431
5. MCCTA error	0.0936	0.3536**	0.4751**	-0.526 **		-0.7604**	0.0713	0.0517	0.0645	-0.0917	-0.0432	-0.0684
6. MCCTA latency	-0.1449	-0.2768*	-0.3399**	0.5307**	-0.7604**		-0.0926	-0.0799	-0.0857	-0.0482	-0.0443	-0.0475
7. SCAT Verbal	-0.0989	-0.0802	-0.1191	-0.0890	0.0713	-0.0926		0.8845**	0.9668**	0.6935**	0.5884**	0.6579**
8. SCAT Numerical	-0.0549	-0.0239	-0.0882	-0.0951	0.0517	-0.0799	0.8845**		0.9732**	0.7747**	0.6945**	0.7548**
9. SCAT Total	-0.0861	-0.0532	-0.1108	-0.0969	0.0645	-0.0857	0.9668**	0.9732**		0.7553**	0.6639**	0.7288**
10. CAT Verbal	0.0045	-0.1184	-0.1991	0.0012	-0.0917	-0.0482	0.6935**	0.7747**	0.7553**		0.8852**	0.9683**
11. CAT Numerical	0.0707	-0.0422	-0.1346	-0.0814	-0.0432	-0.0443	0.5884**	0.6945**	0.6639**	0.8852**		0.9733**
12. CAT Total	0.0402	-0.0810	-0.1704	-0.0431	-0.0684	-0.0475	0.6579**	0.7548**	0.7288**	0.9683**	0.9733**	

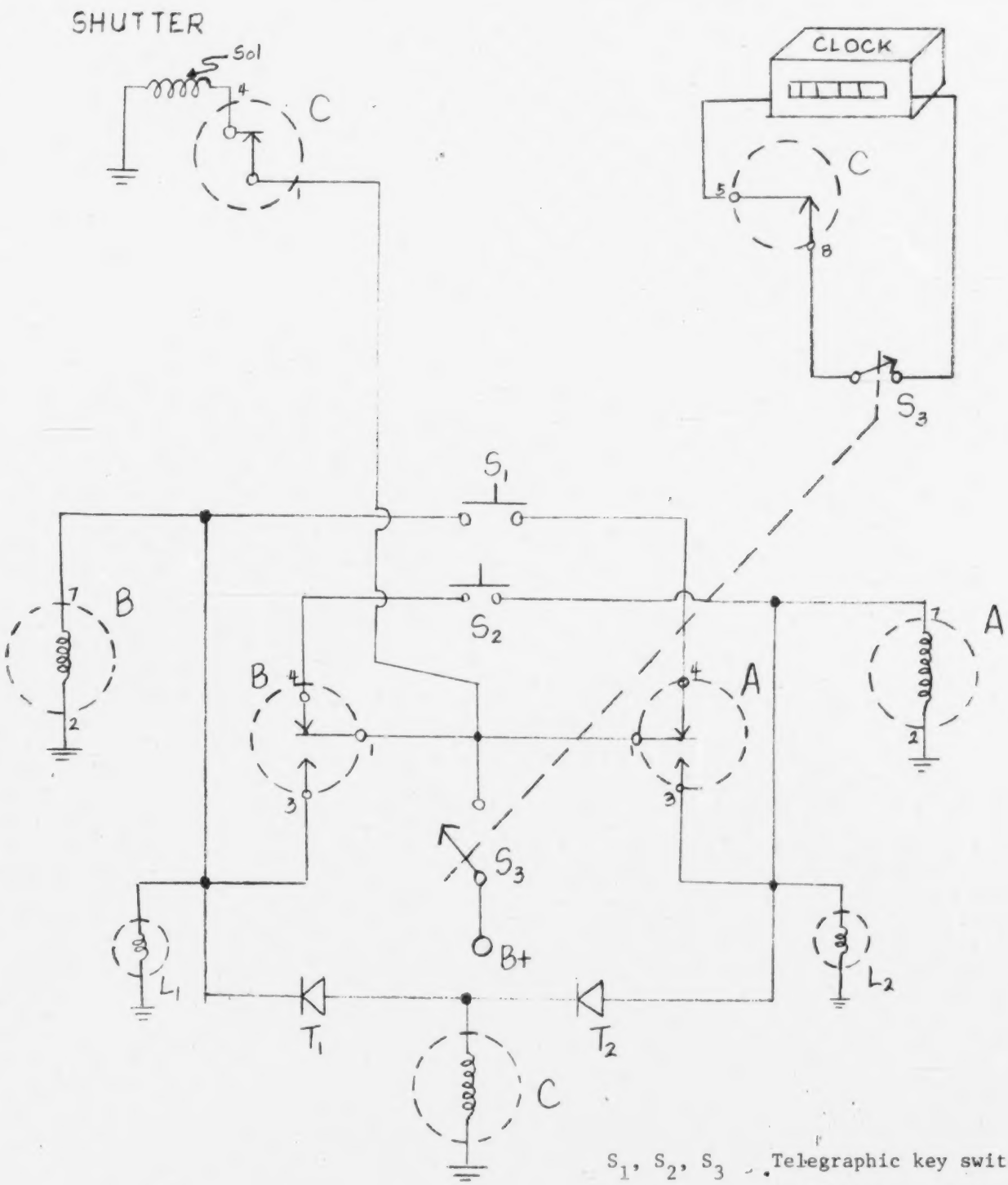
N = 40 per grade level

Table VI

The means for age, MFF variables and MCCTA variables by grade levels

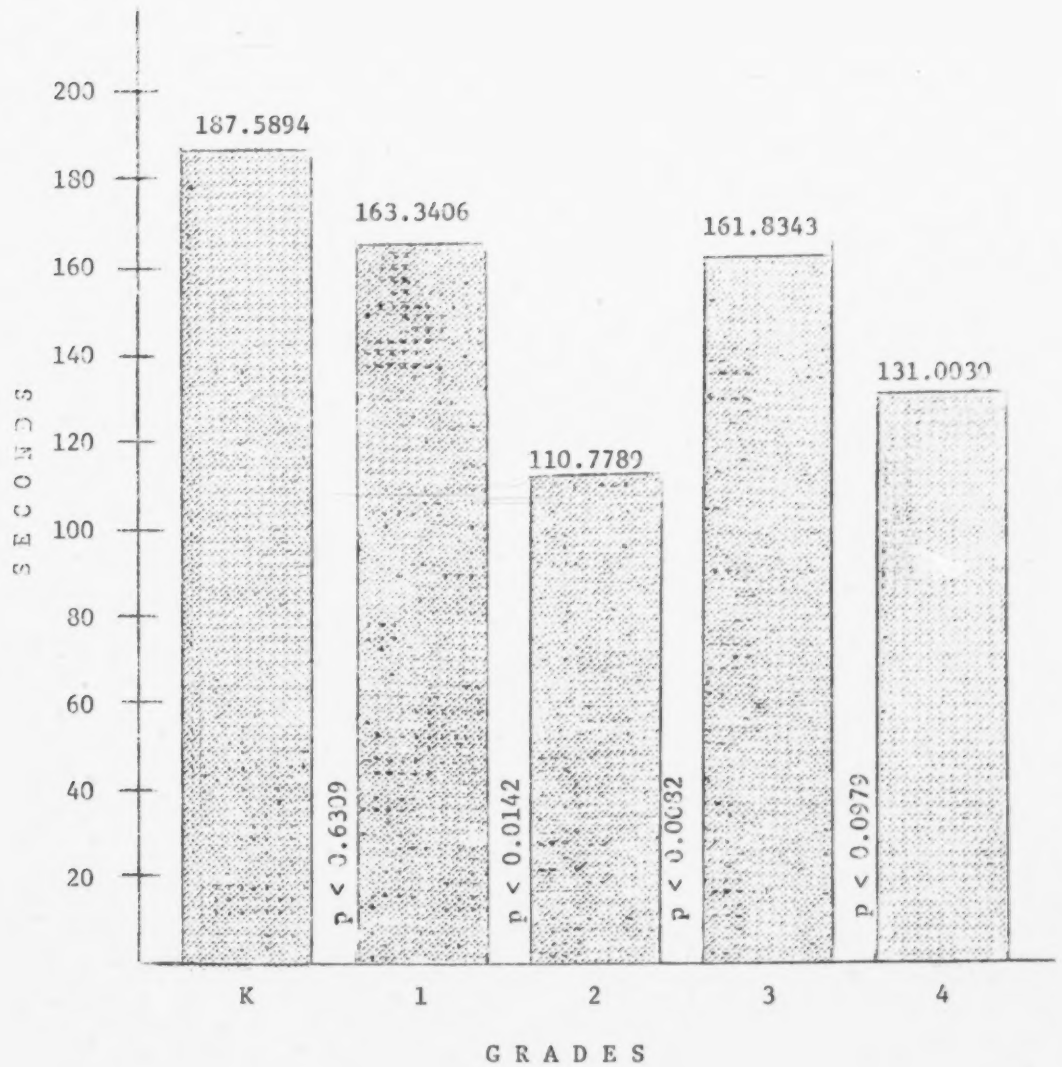
Grades	Age	MFF error first	MFF error crit	MFF latency	MCCTA error	MCCTA latency
1. Kindergarten	5.7592	8.5250	20.4250	87.6500	17.8000	187.5894
2. First	6.8797	7.0750	13.9000	139.2250	16.9250	163.3406
3. Second	7.8327	7.2250	13.4750	119.0000	17.0000	110.7759
4. Third	8.7912	6.1750	10.8750	134.8125	13.8000	161.8343
5. Fourth	9.7875	5.7750	10.0000	146.9125	15.0000	131.0030

SCHEMATIC DRAWING OF MULTI-CHOICE
CONCEPTUAL TEMPO APPARATUS (MCCTA)



Clock	Digital stop clock	S_1, S_2, S_3	Telegraphic key switches
T_1, T_2	Transistors	A, B, C	Double-pole, double-throw toggle switch
B+	Regulated power supply	L_1, L_2	Lightbulb
		Sol	Rotary Solenoid

Figure 1


MCCTA LATENCY
SECONDS
200
180
160
140
120
100
80
60
40
20
187.5894
163.3406
110.7789
161.8343
131.0039
p < 0.6309
p < 0.0142
p < 0.0032
p < 0.0979
K
1
2
3
4
GRADES